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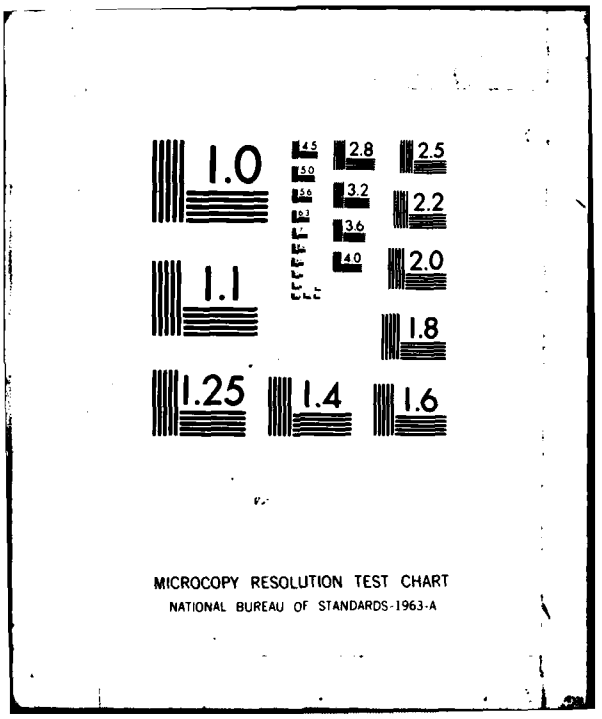
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OCTOBER 1981

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PROGRAM PLAN FOR DATA TRANSFER BETWEEN COMBAT SYSTEM COMPONENTS

NAVAL SEA SYSTEMS COMMAND, COMBAT SYSTEM ENGINEERING OFFICE

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PROGRAM PLAN FOR DATA TRANSFER BETWEEN COMBAT SYSTEM COMPONENTS

October 1981

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PROGRAM PLAN FOR

DATA TRANSFER BETWEEN

COMBAT SYSTEM COMPONENTS

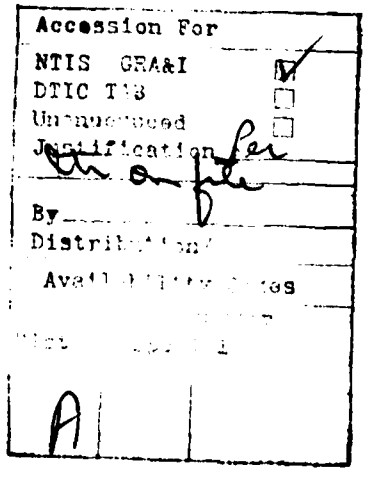
October 1981

NAVAL SEA SYSTEMS COMMAND

COMBAT SYSTEM ENGINEERING OFFICE

FOREWORD

This plan presents a program for the development of an inter-computer/peripheral data transfer mechanism specification for information transfer between combat system components by means of a shared data path, such as a data bus. This specification will be applied initially to the next generation Guided Missile Destroyer, DDGX.



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CHAPTER ONE

INTRODUCTION

1.1 PURPOSE

The purpose of this plan is to structure a program for the development of a specification for a mechanism for information transfer between combat system components (inter-computer/peripheral data-transfer) by means of a shared data path, such as a data bus. Figure 1 depicts a generic data bus concept as an alternative to traditional point-to-point interconnections used with weapons, sensors, computers, and peripherals. This specification will be applied initially to the next-generation Guided Missile Destroyer, DDGX. Concurrent efforts will develop specifications for other classes of ships to support both new-construction and major-upgrade programs.

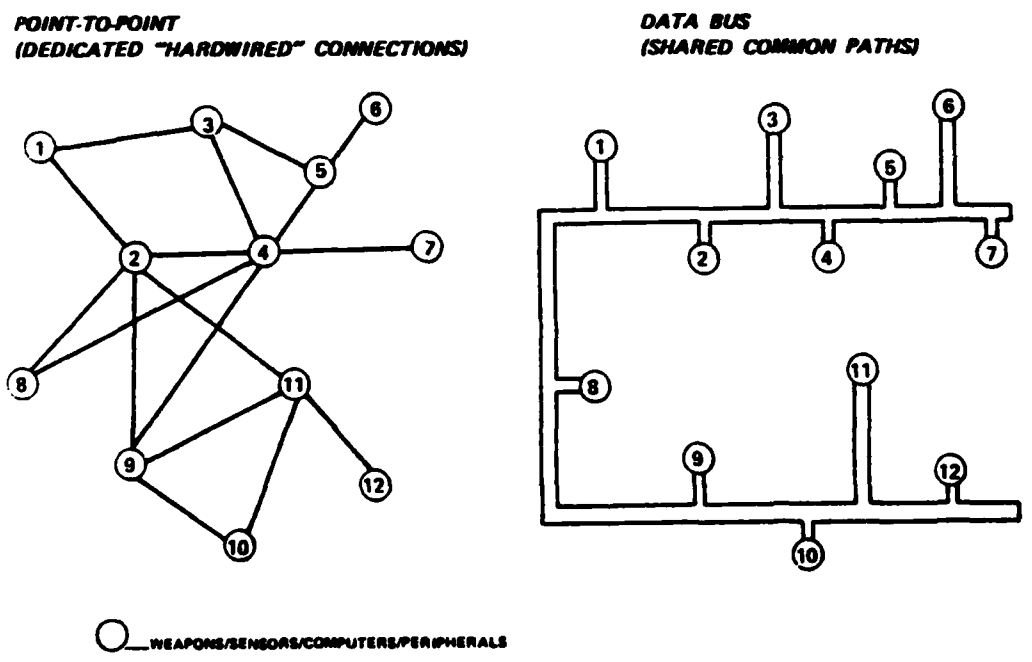


Figure 1. ALTERNATIVE TO POINT-TO-POINT INTERCONNECTIONS

1.2 BACKGROUND

There is great interest in the use of data buses as an alternative to point-to-point interconnections in surface combat systems. In 1978, the

Deputy Assistant Secretary to the Navy (Research, Engineering and Systems) sponsored a Data Bus Panel to investigate the issues. The Air Force has almost ten years' experience employing MIL-STD-1553 as a Government-furnished information (GFI) data bus standard. The Naval Air Systems Command (NAVAIR) currently is adopting the same approach in the F-18, which uses two AN/AYK-14s with MIL-STD-1553 interfaces. In addition, the Navy AN/UYK-43 and AN/UYK-44 computer procurements will provide this bus interface option, as well as other point-to-point interfaces, like STANAG 4153, that are suitable interfaces between components and external terminals. Commercial airline manufacturers began employing data bus standards more than 20 years ago. Industry is actively pursuing independent research and development (IR&D) programs to gain a technical understanding of bus applications and to prepare for future system procurements.

Although the advantages of using a data bus throughout a combat system are yet to be validated, it is clear that some major applications of limited scope will be practical in the near future and have the potential of providing substantial benefits to the Navy.

Distributed data processing with data busing has the potential for solving several problems, two of which are discussed here. First, computations required for the DDGX type combatant are beyond the capability of even the fastest single-processor computer. Thus, it is already necessary to employ simultaneous processing in a great number of interconnected processors. Faster circuits, e.g., very high speed integrated circuits (VHSIC), are being researched but will not be available for application before the 1990s. Even then, the growing complexity of the problem may still require multiple processors. An additional problem is that the adaptation of existing equipment to meet more intense threats is leading to increasingly complex designs. More adaptable and extensible approaches are necessary.

There exists for newer ship classes a reasonably well defined functional hierarchy of systems and equipments:

- Level I - Total ship
- Level II - Ship functions (e.g., combat system, mobility)
- Level III - Subsystem or component (e.g., a total warfare area weapon system)
- Level IV - Elements (e.g., a radar, launcher, or sonar)

For lower-tier (Level IV) elements in the hierarchy, engineers have already chosen distributed processing and busing as effective solutions to requirements. For example, subsystems of the vertical launch system (VLS) and the AEGIS weapon system currently employ data buses. Problems at the higher tiers are related to (1) lack of a recognized central authority to provide the consistent technical direction to implement distributed processing and data busing across many subsystems, and (2) to the real-life constraints imposed by the use of existing designs and computer programs. Therefore, the validity of conclusions is heavily dependent on the level investigated in this hierarchy.

DDGX represents a current opportunity to move toward distributed processing and new data-transmission architectures. The DDGX combat system is being

designed to provide maximum flexibility for system and element-level hardware and computer program upgrades during its life. The combat system is to be designed to be highly survivable and to have a maximum number of alternative or casualty modes of operation. To support these concepts, the Navy must consider the concepts of distributed processing and a compatible data transfer system, as well as traditional point-to-point connected architectures, in the design of the pDGX combat system. The Combat System Engineering Agent (CSEA) for the DDGX program needs to define and develop the requirements for an advanced extensible, flexible, and survivable data-processing/data-transfer architecture suitable for use throughout the entire combat system. He must review applicable Navy data-handling (data-processing/data-transfer) developments and make appropriate recommendations (1) to ensure proper operation of the entire ship and combat system data-handling architectures (wherein many "ship services" functions affect the combat system) and (2) to ensure system flexibility and survivability. The defined architecture is to be compatible with AN/UYK-43/44 and/or AN/UYK-7/20 standard Navy computers and, where feasible, use standard Navy languages, executive programs, and protocols. This effort provides for both near-term inclusion in the combat system of currently planned elements (near-term inventory items that are candidates for first ship use) and for long-term developments of combat system elements. The degree to which such a system will use developmental and/or commercial equipment in the processing phases of land-based test and evaluation will be addressed in future planning.

Future opportunities will be in the Ship System Engineering Standards (SSES) program. The objective of the SSES program is to achieve physical and functional separation of the platform, hull, and its payload elements (Level IV). Engineering standards will be developed to allow the design and construction of the platform independent of, but in concert with, the combat system elements. These standards will be the basis for the development of new classes of ships that are designed and constructed to accommodate easily and quickly, through modular interchangeability, any of the payloads most appropriate to those generic platforms. These standards will also be implemented, as appropriate, in the conversion and modernization of existing ships.

1.3 SCOPE

The specification effort addressed in this plan will define the mechanisms necessary for the components (computer program modules in computers and peripherals) that are a part of weapon, sensor, and control subsystems to communicate effectively among themselves. To this end, a series of interfaces, protocols, and control operations will be specified. This effort will address both the situations in which the physical structure of equipment components (e.g., AN/UYK-7) cannot be cost-effectively modified and the situations, such as in new designs, in which they can be.

Figure 2 provides a simplified representation of one approach to the interfaces. Where a data transfer terminal must be added externally, as to existing equipment using a current MIL-STD-1397 or the new STANAG 4153 interface, the user interface, the external terminal interface, and the connector/cable interface will be specified in sufficient detail so that there can be no ambiguity among various subscribers, data transfer terminal vendors, and

connector/cable vendors. Where the data transfer terminal is added internally, the user interface and the connector/cable interface will be specified in sufficient detail so that there can be no ambiguity between various subscribers and connector/cable vendors. The precise control operations and interfaces will be described functionally, specifying minimum performance requirements, associated protocols, and applicable constraints such as power, weight, cabling, size, and memory requirements.

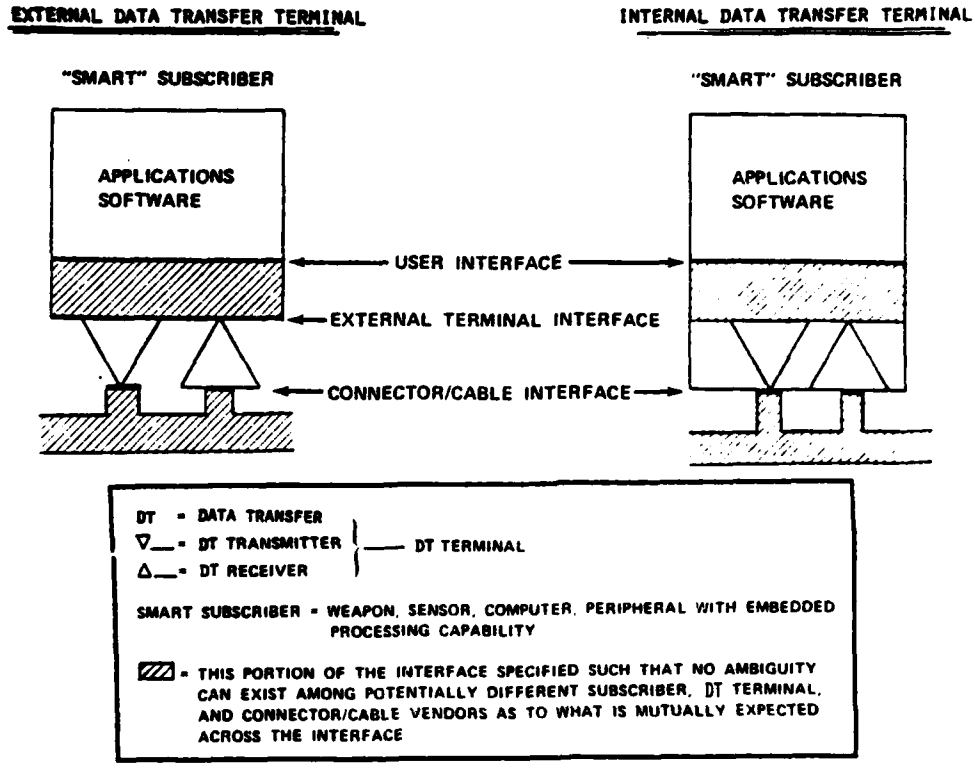


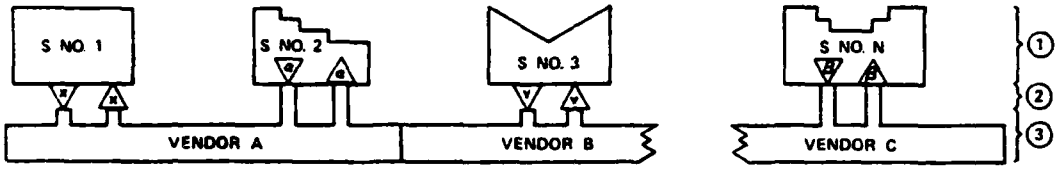
Figure 2. EXAMPLE OF INTERFACE RELATIONSHIPS

With well defined interfaces and protocols, and functionally defined "black boxes" between interfaces, this specification will permit effective competitive procurement of system elements with a common-path interconnection, if desired by the developer. Such freedom of implementation should permit the future evolution of effective common paths throughout a combat system. Figure 3 depicts the potential variability in data transfer implementation in accordance with the approach outlined in Figure 2, showing different subscribers, different data transfer terminals, and connectors and cables supplied by different vendors.

The technical and management insight gained by NAVAIR and the Air Force in the use of the Government-furnished information (GFI) MIL-STD-1553 avionics bus will be an important factor in the development of this specification.

Common user interfaces, future subsystem introduction, and technology insertion will be high-priority factors considered in the protocol deliberations.

In carrying out the detailed deliberations, it will be necessary to consider cabling technology (copper and fiber optics); industry IR&D projects; standardization efforts by the North Atlantic Treaty Organization (NATO), techhnical societies, the National Bureau of Standards, and industry; compatibility with a variety of combat system architectures; effect of application and executive computer programs; and all hardware and software aspects, of input/output (I/O) structure and ship signal data transfer interfaces.



(1) DIFFERENT SUBSCRIBERS
(SOME DT TERMINALS INTEGRATED WITHIN SUBSCRIBER HARDWARE)

(2) DIFFERENT DT TERMINALS
(IDENTICAL INPUT/OUTPUT ATTRIBUTES)

(3) DIFFERENT VENDOR-SUPPLIED CONNECTORS & CABLE
(IDENTICAL PHYSICAL ATTRIBUTES)

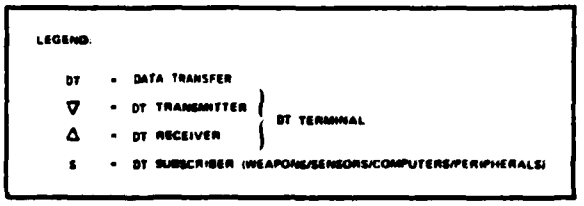


Figure 1. EXAMPLE OF DATA TRANSFER IMPLEMENTATION VARIETY

Except as indicated above, this effort will not directly specify such far-reaching areas as combat system architectures, computer architectures, computer programming languages, Navy standard computer and peripheral acquisitions, and ship signal data transfer systems.

CHAPTER TWO

MANAGEMENT

2.1 OVERVIEW

The management organization for the development of the data transfer specification is designed to provide interaction between combat system users, engineers, Navy system acquisition managers and the DDGX CSEA. A Data Transfer specification working group (DTSWG) and an advisory panel will be formed.

2.2 DATA TRANSFER SPECIFICATION WORKING GROUP

The primary objective of the DTSWG is to produce the data transfer specification. The group will consist of technical personnel from Naval Sea Systems Command (NAVSEA), Naval Surface Weapons Center (NSWC), Naval Ocean Systems Center (NOSC), Naval Underwater System Center (NUSC), Johns Hopkins University/Applied Physics Laboratory (JHU/APL), ARINC Research Corporation, and the DDGX CSEA.

Industrial activities, Navy acquisition managers concerned with data transfer development, and combat system engineers will be solicited for user requirements and technical comments. NAVSEA 06DC will chair the working group; ARINC Research will provide the secretariat for the working group and will, at the direction of the chairman, maintain minutes of the meetings, develop and distribute meeting agendas, and review and consolidate industry comments concerning the specification as it is being developed.

2.3 ADVISORY PANEL

The purpose of the advisory panel is to conduct in-progress reviews of the DTSWG efforts and to provide guidance as necessary. The panel will be chaired by SEA-06D and will initially include representation from SEA-313, -61, -62, -63, -06DC, -06D6, PMS-400, and PMS-408.

3.3 APPLICATION SCOPING

The initial task for the DTSWG will be to focus on projected Navy combat system requirements and develop an initial set of requirements for the data transfer specifications. Together with the application studies, these will be used later to refine the requirements.

3.4 DATA COLLECTION

In order to assure a good engineering foundation, data will be collected on data-exchange requirements, such as data rates, acceptable delays, message size, message traffic, and acceptable error rates. This effort will be restricted to the elements expected in the combat systems. The exact parameters of combat system elements will not be known for some time, but existing implementations of elements of other combat systems can be examined. Where completely new elements are expected, the DTSWG must rely on engineering judgment. In order to obtain the necessary data, the assistance of various Navy participating managers (PARM) and element contractors will be requested.

3.5 STRAWMEN/DRAFT SPECIFICATIONS DEVELOPMENT

At least three data transfer strawmen will be developed for DDGX, of which one will be the Standard Information Transfer Architecture for Combat Systems (SITACS) developed by NAVSEA-61. The strawmen will be modified as necessary to represent additional or different requirements for other class ships as part of SSES. The strawmen will represent alternate technical approaches for use with DDGX and SSES as appropriate. They will be forwarded to Navy system acquisition managers and to industry for review. As the design progresses and comments are received, a draft specification will be developed from each strawman to further define each technical approach. These draft specifications will be forwarded for comment to the members of the Navy and industrial team who reviewed the strawmen.

3.6 DDGX/SSES APPLICATION ANALYSES

The strawmen, draft specifications, and, ultimately, the final specification will be examined for suitability of application to the DDGX combat system. Items such as ship schedule, development time, cost, combat system design alternatives incorporating data transfer systems, producibility, and advantages or disadvantages to DDGX of the various strawmen, draft specifications, and final specification will be analyzed. This work will be performed by the DDGX Combat System Engineering Office, Technical Support Agent, Combat System Engineering Agent, consultants, and industry representatives familiar with combat system elements and data transfer implementations; guidance and direction will be provided by the DTSWG. Any additional factors pertinent to SSES will be analyzed by the DTSWG, consultants, and industry representatives familiar with combat system elements and data transfer implementations in coordination with SEA-06DC.

3.7 INDUSTRY AND ACQUISITION MANAGER REVIEWS

Timely reviews will be solicited from both the data transfer user community (i.e., applicable system and subsystem acquisition managers and their industry contractors) and the data transfer producing community (i.e., appropriate industry data transfer developers). Following receipt of formal written reviews of the strawmen versions and draft specifications, the DTSWG will invite the reviewers to report orally. All reviewers are expected to quantify alternatives and be prepared to discuss their selections. Open technical discussions will be encouraged.

3.8 REVIEW MEETINGS

The first meeting will be held following DDGX, industry and acquisition management review of the strawmen. Following consideration of the comments, the DTSWG will propose a single draft specification, which will be distributed for review; another user-producer meeting will then be convened.

The DTSWG will establish agenda items that address various aspects of the proposed strawmen or specifications. The secretariat will provide the agenda to the potential meeting attendees when the meeting is announced. During the review meetings, attendees will discuss their concerns and subcommittees will be established to rewrite portions of the strawmen or draft specifications so that controversies or conflicts can be resolved during succeeding days of the meeting. An advisory panel will meet to review progress of the DTSWG as requested by the chairman, SEA-06D.

3.9 DDGX SPECIFICATION DEVELOPMENT

A specification for a mechanism for transfer of DDGX intercomputer/peripheral data will be prepared, incorporating the consensus developed during the reviews of the strawman specifications. This DDGX specification will be forwarded to the DDGX CSEA for implementation.

3.10 SSES SPECIFICATION DEVELOPMENT

Changes necessary to accommodate combat systems of other classes of ships will be made to the DDGX specification to support its use in the SSES program. These changes will satisfy information-transfer requirements of differing combat system architectures not met by the DDGX specification. The specification will then be forwarded to NAVSEA-313.

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